

WHAT IS CLAIMED IS:

1. A sorbent composition suitable for removing sulfur from a hydrocarbon-containing fluid, said sorbent composition comprising:
 - a reduced-valence promoter; and
 - a steam-treated support.
2. A sorbent composition in accordance with claim 1 wherein said steam-treated support comprises zinc oxide.
3. A sorbent composition in accordance with claim 2 wherein said reduced-valence promoter comprises a metal selected from the group consisting of nickel, cobalt, iron, manganese, copper, zinc, molybdenum, tungsten, silver, tin, vanadium, antimony, and combinations thereof.
4. A sorbent composition in accordance with claim 3 wherein said reduced-valence promoter has a valence of less than 2.
5. A sorbent composition in accordance with claim 1 wherein said steam-treated support comprises zinc oxide, alumina, and silica.
6. A sorbent composition in accordance with claim 5 wherein said reduced-valence promoter comprises nickel.
7. A sorbent composition in accordance with claim 6 wherein said zinc oxide is present in the range of from about 10 to about 90 weight percent, said silica is present in an amount in the range of from about 5 to about

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85 weight percent, said alumina is present in an amount in the range of from about 1 to about 30 weight percent, and said reduced-valence promoter is present in an amount in the range of from about 0.5 to about 50 weight percent.

8. A sorbent composition in accordance with claim 7 wherein said reduced-valence promoter has a valence of zero.

9. A sorbent composition in accordance with claim 1 wherein said steam-treated support comprises zinc oxide, alumina, silica, zinc silicate, and zinc aluminate.

10. A sorbent composition in accordance with claim 9 wherein said steam-treated support has been steam-treated under conditions sufficient to form said zinc silicate from at least a portion of said zinc oxide and said silica.

11. A sorbent composition in accordance with claim 10 wherein said steam-treated support has been steam-treated under conditions sufficient to form said zinc aluminate from at least a portion of said zinc oxide and said alumina.

12. A sorbent composition in accordance with claim 9 wherein said steam-treated support has been steam-treated at a temperature in the range of from about 400°C to about 1500°C and for a period in the range of from about 0.5 hours to about 24 hours.

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13. A sorbent composition in accordance with claim 12
wherein said reduced-valence promoter comprises nickel.

14. A sorbent composition in accordance with claim 13
wherein said sorbent composition is a particulate in the form of a microsphere.

15. A sorbent composition in accordance with claim 14
wherein said microsphere has a mean particle size in the range of from about 1 micrometer to about 500 micrometers.

16. A sorbent composition in accordance with claim 15
wherein said reduced-valence promoter has a valence of zero.

17. A sorbent composition in accordance with claim 16
wherein said sorbent composition has a 5-hour attrition percentage value of less than 30 percent.

18. A process of making a sorbent composition, said process comprising the steps of:

- admixing a first support component and a second support component to provide a support mix;
- particulating the support mix to provide a support particulate;
- steam-treating said support particulate to provide a steam-treated

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particulate;

(d) incorporating said steam-treated particulate with a promoter to provide a promoted particulate having an unreduced promoter; and

5 (e) reducing said promoted particulate to provide a reduced sorbent composition having a reduced-valence promoter.

19. A process in accordance with claim 18 wherein said first support component comprises zinc oxide and said second support component comprises alumina and silica.

20. A process in accordance with claim 19 wherein said steam-treating is conducted at conditions sufficient to form zinc silicate from at least a portion of said zinc oxide and said silica present in said support particulate.

21. A process in accordance with claim 19 wherein said steam-treating is conducted at a temperature sufficient to form zinc aluminate from at least a portion of said zinc oxide and said alumina present in said support particulate.

22. A process in accordance with claim 19 wherein said steam-treating is conducted at a temperature in the range of from about 400°C to about 1500°C and for a period in the range of from about 0.5 hours to about 24 hours.

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23. A process in accordance with claim 22 wherein said reduced-valence promoter component has a valence which is less than the valence of said unreduced promoter.

24. A process in accordance with claim 23 wherein said promoter comprises nickel.

25. A process in accordance with claim 24 wherein said reduced-valence promoter has a valence of less than 2.

26. A process in accordance with claim 18 wherein said support particulate is dried and calcined before steam-treating.

27. A process in accordance with claim 18 wherein said promoted particulate is dried and calcined before reducing.

28. A process in accordance with claim 18 wherein said steam treating is conducted at a temperature in the range of from about 750°C to about 1,000°C and for a period in the range of from about 4 hours to about 10 hours.

29. A process in accordance with claim 18 wherein said promoter comprises nickel.

30. A process in accordance with claim 29 wherein said reduced-valence promoter has a valence of less than 2.

31. A process in accordance with claim 29 wherein said reduced-valence promoter has a valence of zero.

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32. A composition prepared by the process of claim 17.

33. A composition prepared by the process of claim 30.

34. A process for removing sulfur from a hydrocarbon-containing fluid stream, said process comprising the steps of:

(a) contacting said hydrocarbon-containing fluid stream with a sorbent composition comprising a reduced-valence promoter and a steam-treated

5 support in a desulfurization zone under conditions such that there is formed a desulfurized fluid stream and a sulfurized sorbent;

(b) separating said desulfurized fluid stream from said sulfurized sorbent;

10 (c) regenerating at least a portion of the separated sulfurized sorbent in a regeneration zone so as to remove at least a portion of the sulfur therefrom and provide a desulfurized sorbent;

(d) reducing said desulfurized sorbent in an activation zone to provide a reduced sorbent composition which will affect the removal of sulfur from said hydrocarbon-containing fluid stream when contacted with the same;

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(e) returning at least a portion of said reduced sorbent composition to said desulfurization zone.

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35. A process in accordance with claim 34 wherein said steam-treated support component comprises zinc oxide, alumina, and silica.

36. A process in accordance with claim 35 wherein said reduced-valence promoter comprises a metal selected from the group consisting of nickel, cobalt, iron, manganese, copper, zinc, molybdenum, tungsten, silver, tin, vanadium, antimony, and combinations thereof.

37. A process in accordance with claim 36 wherein said sorbent composition comprises said zinc oxide in an amount in the range of from about 10 to about 90 weight percent, said alumina in an amount in the range of from about 1 to about 30 weight percent, said silica in an amount in the range of from about 5 to about 85 weight percent, and said reduced-valence promoter component in an amount in the range of from about 0.5 to about 50 weight percent.

38. A process in accordance with claim 37 wherein said sorbent composition further comprises zinc silicate.

39. A process in accordance with claim 38 wherein said sorbent composition further comprises zinc aluminate.

40. A process in accordance with claim 39 wherein said reduced-valence promoter component has a valence of less than 2.

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41. A process in accordance with claim 40 wherein said reduced-valence promoter component comprises nickel.

42. A process in accordance with claim 34 wherein said contacting is carried out at a temperature in the range of from about 100°F to about 1000°F and at a pressure in the range of from about 15 to about 1500 psia.

43. A process in accordance with claim 42 wherein said regeneration is carried out at a temperature in the range of from about 0°F to about 1500°F and a pressure in the range of from about 25 to about 500 psia.

44. A process in accordance with claim 43 wherein there is employed air as a regeneration agent in said regeneration zone.

45. A process in accordance with claim 34 wherein said desulfurized sorbent is subjected to reduction with hydrogen in said activation zone, wherein during reduction said activation zone is maintained at a temperature in the range of from about 100°F to about 1500°F and a pressure in the range of from about 15 to about 1500 psia.

46. A process in accordance with claim 34 wherein the separated sulfurized sorbent is stripped prior to introduction into said regeneration zone.

47. A process in accordance with claim 34 wherein said desulfurized sorbent is stripped prior to introduction to said activation zone.

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48. A process in accordance with claim 34 wherein said reduced-valence promoter has a valence of less than 2.

49. A process in accordance with claim 34 wherein said reduced-valence promoter has a valence of zero.

50. A process in accordance with claim 49 wherein said reduced-valence promoter comprises nickel.

51. A process in accordance with claim 34 wherein said hydrocarbon-containing fluid stream is cracked-gasoline.

52. A process in accordance with claim 34 wherein said hydrocarbon-containing fluid stream is diesel.

53. The product produced by the process of claim 51.

54. The product produced by the process of claim 52.

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